TESTING FOR METHANE IN OUT-OF-REACH PLACES

By M. L. Davis

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INTRODUCTION AND ACKNOWLEDGMENTS

The principal causes of many methane-gas explosions that have occurred in anthracite mines, especially in thick pitching veins, during recent years can be traced to lack of a satisfactory method of testing for such gas in areas adjacent to those in which blasting is to be done or other sources of ignition introduced. As coal-mine officials and inspectors are required to make examinations for methane in all accessible open workings, including high places, and permissible flame safety lamps have been used almost universally for making these examinations, considerable difficulty has been experienced in proper testing of atmospheres at elevations beyond the normal reach of the examiner, and resultant explosions have often indicated perfunctory tests. The accepted practice of testing for gas in voids or high places generally consists of raising a flame safety lamp, suspended from the end of a long drill, stick, or pipe, into the atmosphere to be tested. Disadvantages noted are: Action of the flame within the lamp cannot be seen readily when the lamp is more than 18 inches overhead, the flame will not be extinguished when less than about 4-1/2 percent of methane is present, and indications of small percentages of methane within the lamp may disappear entirely while the lamp is being lowered slowly to view; the examiner must usually be exposed unnecessarily to falling material; and the lamp may fall and be broken. Thus, the need for a more reliable, safe method of testing for gas in out-of-reach places is apparent.

Several electrical methane detectors, tested and approved by the Bureau of Mines, have been used satisfactorily, though infrequently, for making the aforementioned gas tests. Some of these detectors employ a rubber aspirator bulb and rubber tubing of suitable length to draw the atmosphere from high places through and over energized parts of the detector. However, the original expense, susceptibility to damage, and awkwardness of carrying these instruments in steep-pitch workings has precluded their general use in everyday examinations. Although not as efficient as the electrical detector for determining small percentages of methane or as reliable because of the limitations imposed by oxygen-deficient atmospheres, the modern permissible flame safety lamp can, it is believed, be used safely with the rubber aspirator bulb and tubing to greater advantage and with comparative reliability in testing for gas in out-of-reach places. Slight reference to this method of introducing air into a safety lamp is made in a Bureau of Mines publication of 1924,[2] and it is quite possible that the method has been utilized in some manner by individuals in American mines during the intervening years. A similar method was used in connection with a nonpermissible Wolf flame safety lamp in at least one coal mine in Japan before World War II. A major change in the construction of this lamp would bar its approval by the Bureau of Mines. An American adaptation of the Wolf lamp, developed

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2/ Paul, J. W., Ilsley, L. C., and Gleim, E. J., Flame Safety Lamps: Bureau of Mines Bull. 227, 1924, 212 pp.

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chiefly for the detection of oxygen deficiency in sewers and similar subsurface passageways, could not meet present Bureau standards for approval.

Two types of flame safety lamps, the Wolf and the Koehler, are used almost exclusively in the United States. These lamps are in too common use to require description. The Bureau of Mines has tested and approved as permissible several models of these two types. Only permissible lamps should be used, as they have certain safety features that nonpermissible lamps do not have.

The flame safety lamp has decidedly definite limitations as a methane detector; it is doubtful whether the average observer can detect less than 1 percent of methane with the ordinary lamp. Even under normal conditions, the safety lamp, although widely used, is not an extremely sensitive or accurate gas-testing device. The average anthracite mine official, however, is not greatly interested in the exact percentage of methane present; he is aware that, when any methane can be detected, ventilation must be improved enough to dilute and carry away the gas and that blasting or other source of ignition must be prohibited in or near the affected area. The method of gas testing herein described presupposes that the safety lamp can, while stagnant and often explosive atmosphere from out-of-reach places is being tested, be kept usually in the ventilating current and always in a safe location, thereby eliminating the danger of thrusting the lamp inadvertently into explosive gas. Several gas explosions resulting from defective flame safety lamps have occurred in the past 10 years.

Information for this report obtained from Bureau of Mines publications on related subjects is respectfully acknowledged. Special acknowledgment is due E. A. Coggeshall and H. A. Schrecengost of the Bureau of Mines and Albert Morgan of the Lehigh Navigation Coal Co., Inc., for their assistance and cooperation. The author is also grateful to the Hon. W. J. Clements, Secretary of the Pennsylvania Department of Mines, for his endorsement of the device and method for testing for gas in high places.

REVIEW OF CONDITIONS

In steep-pitching anthracite veins of a free-running nature, the coal faces of working places often "run away" (that is, the coal falls or slides) and "hang" or stop falling at any elevation short of the ventilation connection directly above, usually the next upper gangway level, owing to a change in the nature of the vein or arching of the face. Methane liberated during the "runaway" is generally trapped within the working place and may fill the entire remaining space, because ventilation cannot be maintained or established therein. Drawing or loading out the loose coal eventually results in gas-filled voids above the loose material, and jamming of large pieces of coal or rock will often create a void immediately above the starting battery or draw hole. Then, too, only the higher part of the void may be filled with methane, and the gas may be drawn toward the draw hole by coal falling or sliding from the face. The gas condition persists until ventilation is established either by the coal falling to an upper-level opening or to an adjacent ventilated place or, occasionally, by normal methods. Blasting of large vein material at or above the starting battery must be done to facilitate loading; and the firing of heavy explosive charges, termed "shake shots," within a void is often necessary to dislodge loose coal at the faces or to start another runaway when usual means of access to the face are impracticable. Another way in which a void occurs is when one side of a working face falls to such height above the other side as to preclude immediate timbering and normal methods of ventilation without excessive danger to the miner. Under such circumstances the lower, solid side of the face must be drilled and blasted if the place is to be advanced.

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Firing of mudcaps or other open, unconfined charges of permissible explosives is common practice at and above draw holes or starting batteries and for "shake shots" in steep-pitching anthracite veins, and these types of shots are permitted by Federal statute under certain specified conditions. Principal among the conditions set forth is that no gas or fire hazard is present when blasting. As stated previously, the methods employed heretofore when testing for gas above starting batteries and in other out-of-reach places have been generally unsatisfactory.

High places inaccessible for ordinary methods of gas testing with a flame safety lamp also exist in flat or slight-pitch workings in thick veins. Small-diameter iron pipes and long poles are often kept available at strategic locations for raising the safety lamp to desired heights.

DESCRIPTION OF DEVICE AND METHOD OF TESTING

Wolf and Koehler flame safety lamps with appurtenances assembled for gas tests in high places are shown at the right in figures 1 and 2, respectively; necessary parts, not assembled, and a leather carrying case are also shown.

The only permanent attachment to either safety lamp is a small brass nipple screwed into the locking ring of the Koehler lamp to provide an air inlet, and this does not affect the normal operation or the permissibility of the lamp in any manner. Other parts are used only when testing for gas in high places. This nipple is made of 5/16-inch-diameter brass stock, 3/4 inch in length, through which a 1/8-inch hole is drilled lengthwise. A quarter inch of one end is cut to 1/4-inch diameter and threaded to 28 gage; and at the other end, the inside is tapped to a depth of 1/2 inch to receive a No. 8-32 headless brass screw, from which the threads along a plane about one-quarter the diameter of the screw have been filed to provide an air-flow regulator. It is important that the opening within the nipple be such that air forced into the lamp by pressing on the aspirator bulb will not cause the flame to flicker or "jump" and yet will be large enough to permit flow of air without applying excessive pressure on the bulb. The 1/4-inch tap in the locking ring can be made easily without removing the ring, by drilling and tapping it from the lower side. This should be done at a point close to one of the reinforcements, as far from the magnetic lock as practicable, and where the nipple will interfere least with viewing the flame.

A rubber band about 1 inch in width encircles the locking ring and part of the fount, closing the baffle securely, when testing with the Koehler safety lamp. At other times the band may be removed from the lamp, left on the fount below the baffle, or even, with the large Koehler lamp, left in place over the baffle, since closing the baffle appears to have no noticeable effect on the operation or efficiency of this lamp.

The outside openings above and below the baffle ring of the Wolf flame safety lamp are closed with a 1-inch rubber band made of that part of a bicycle inner tube that includes the air valve. The valve casing is cut off to about 3/4-inch length and tapped to receive a headless brass screw similar to that described previously. When the rubber band encircles the baffle ring, the band is fitted over the greater part of the locking ring and snugly against the lower side of that part which encloses the magnetic lock, to provide a fairly good air seal.

Other appurtenances necessary for testing for gas in high places are a rubber aspirator bulb of 80-cc. capacity (about 4-1/8 inches in length and 2-1/8 inches in diameter), a 20-foot length of rubber or clear plastic tubing having an inside diameter not greater than 1/4 inch, and a piece of 1/4-inch rubber tubing 8 inches or

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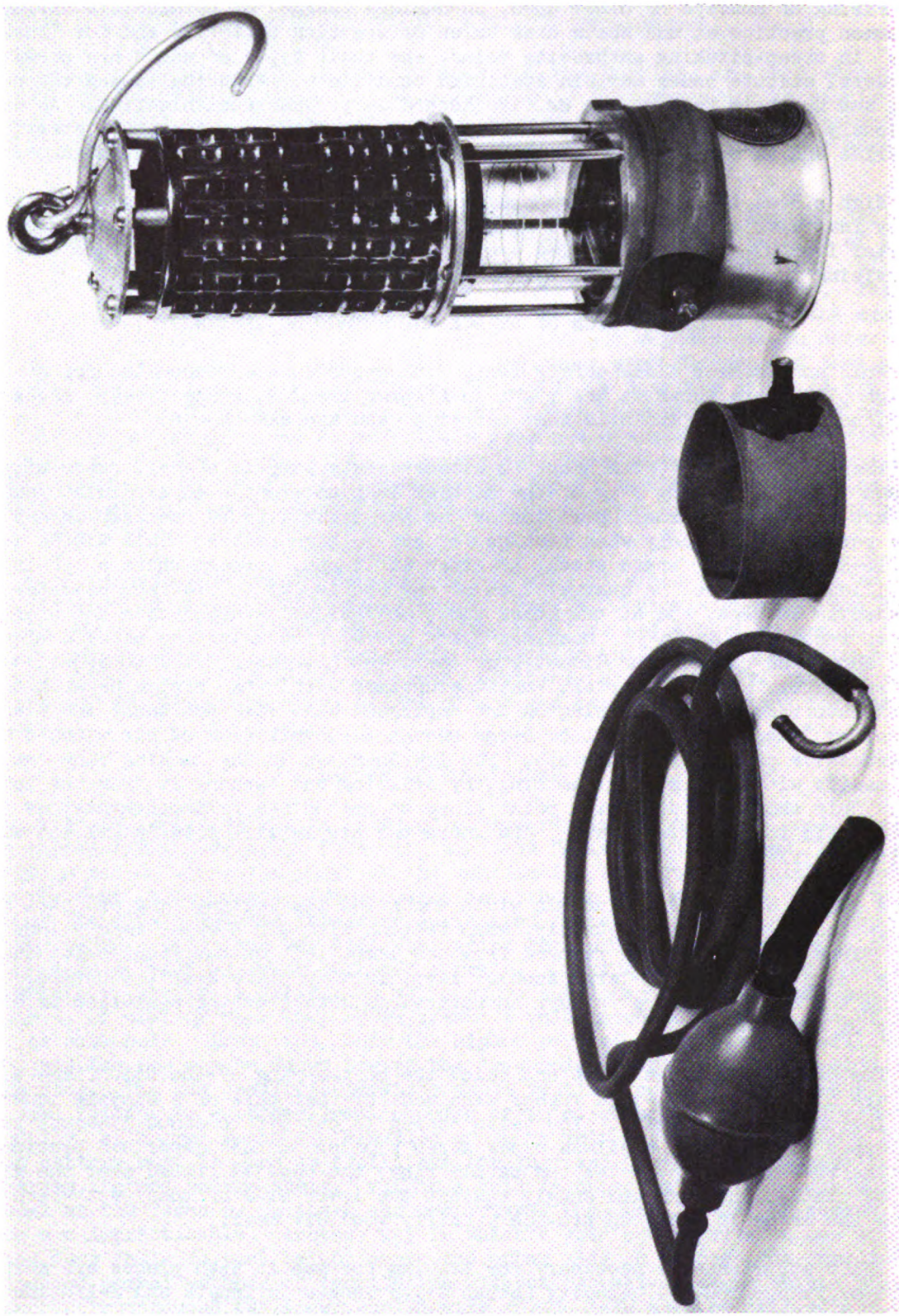

Figure 1. - Appurtenances for testing for methane in out-of-reach places with permissible Wolf flame safety lamp.

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Figure 2. - Appurtenances for testing for methane in out-of-reach places with permissible Koehler flame safety lamp.

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more in length. It is suggested that the longer piece of tubing be of 1/8-inch (i. d.) plastic with 1/16-inch walls, chiefly because of its resistance to kinking. To one end of such tubing may be cemented a "U" tube made of 1/4-inch copper or aluminum tubing and a small piece of fine-mesh iron gauze inserted therein, to prevent the entrance of fine dirt; and a short piece of 1/4-inch rubber tubing is cemented to the other end to facilitate fastening it to the aspirator bulb. A Koehler safety lamp with an aspirator bulb and tubing attached thereto is shown in figure 3.

A method of testing for gas within a void in a steep-pitch loading place, using a "boomer" stick to elevate the intake tubing, is pictured in figure 4. After the stick with the tubing is placed firmly, the lower end of the tubing is attached to the flame safety lamp and the test made, as shown in figure 3, while the examiner is in a safe place not exposed to falls of material. The lamp may be held in one hand when testing or hung on a nail in a convenient timber or on a nail in the stick, as the occasion demands. The "boomer" stick, one of several local names for similar sticks, is made of 1- by 2-inch lumber in 6-foot lengths by one operating company and kept available principally for placing explosive charges above the starting batteries. Similar sticks are often made of rough lumber; officials of one company operating in thick, flat veins propose to use small-diameter iron pipes for raising the tubing; and, in flat or slight-pitch workings, officials may carry with them collapsible wooden tamping bars or telescopic aluminum rods for this purpose.

Each normal compression of the ordinary 80-cc. aspirating bulb displaces a volume of only about 30 cc. It is essential therefore when 20 feet of 1/8-inch tubing is used in making a gas test, that the aspirator bulb be compressed usually at least 7 times for each test to get maximum results. However, only 3 or 4 squeezes of the bulb will be necessary to show the presence of methane when high percentages of the gas are encountered. When such tubing is used and the regulator within the brass nipple is adjusted properly, the aspirator bulb can be compressed normally at the rate of 30 to 36 times a minute. The bulb can be used efficiently with 1/8-inch tubing at least 40 feet in length.

Permissible flame safety lamps with which experiments were conducted include the regular-size Wolf, Koehler round-wick, and Koehler flat-wick, the medium-size Koehler, and the junior Wolf lamps, each equipped with a glass chimney etched at 1/4-inch intervals. With a testing flame about 3/4 inch in height (usually to the second etched ring), each lamp indicates a flame elongation of about 1/8 inch for each 1 percent of methane present; that is, an elongation of 1/8 inch for a 1-percent methane mixture and 1/2 inch for 4 percent of methane. Results obtained with the "capping" or nonluminous testing flame are virtually the same as those in normal operation of each safety lamp; however, exact determinations of less than 2 percent of methane are difficult because of the rapidity with which the gas is consumed by or rises above the flame. Although the elongations and the "caps" remain fairly uniform between aspirations, the percentage of methane must be determined by the extreme height of the flame or "cap".

The intake tubing with a slender support can often be thrust safely into openings where a flame safety lamp will not enter, such as crevices between large pieces of vein material within a draw hole or immediately above the starting battery, when gas tests are necessary before blasting in such places. One operating company proposes to employ a similar method for testing in voids encountered by drill holes where "long-hole" blasting is done. It is obvious that the method can be used advantageously to test for gas over high falls in flat workings, especially when it is unsafe for the examiner to ascend such falls.

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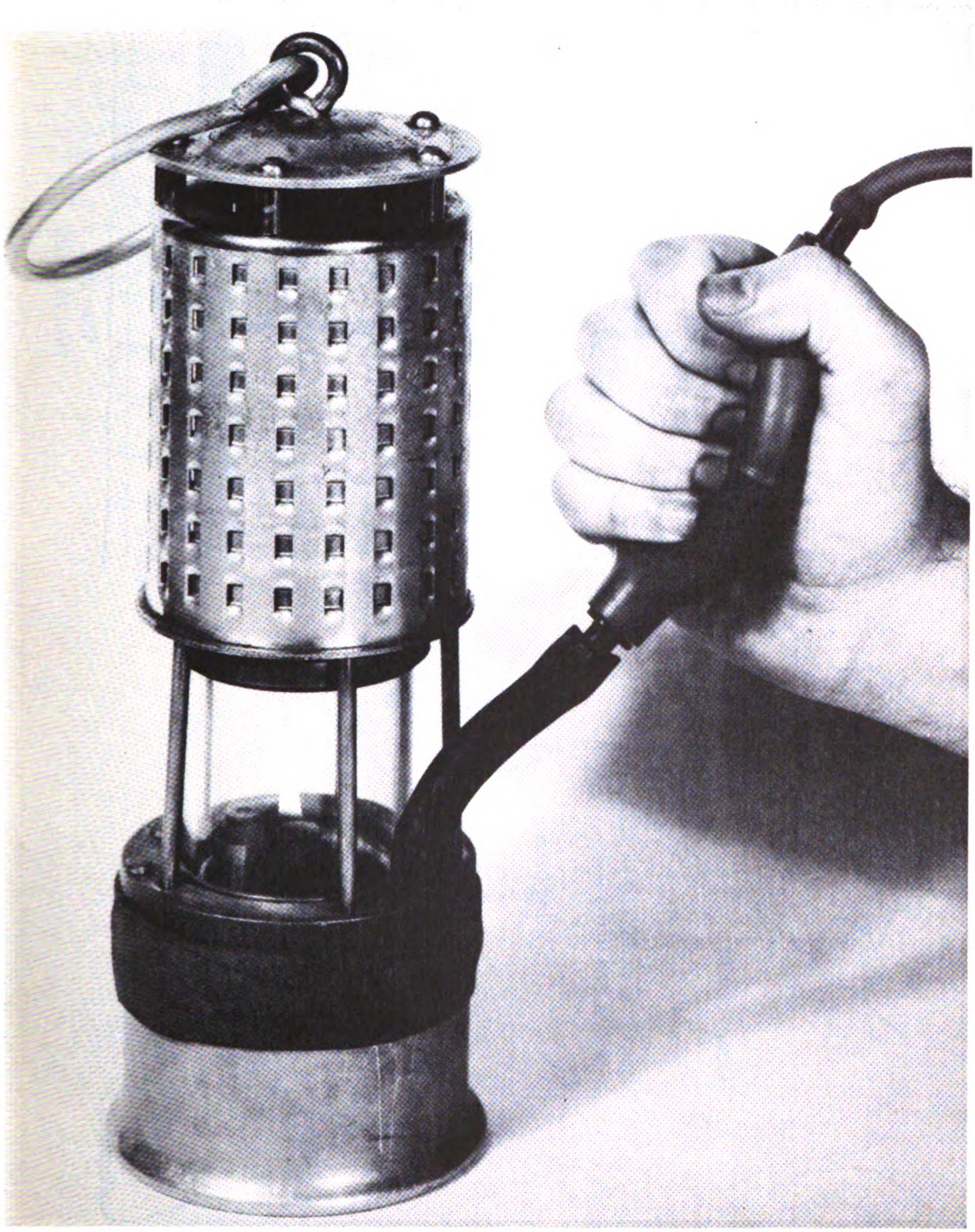

Figure 3. - Device assembled for testing for methane in high places with permissible Koehler flame safety lamp.

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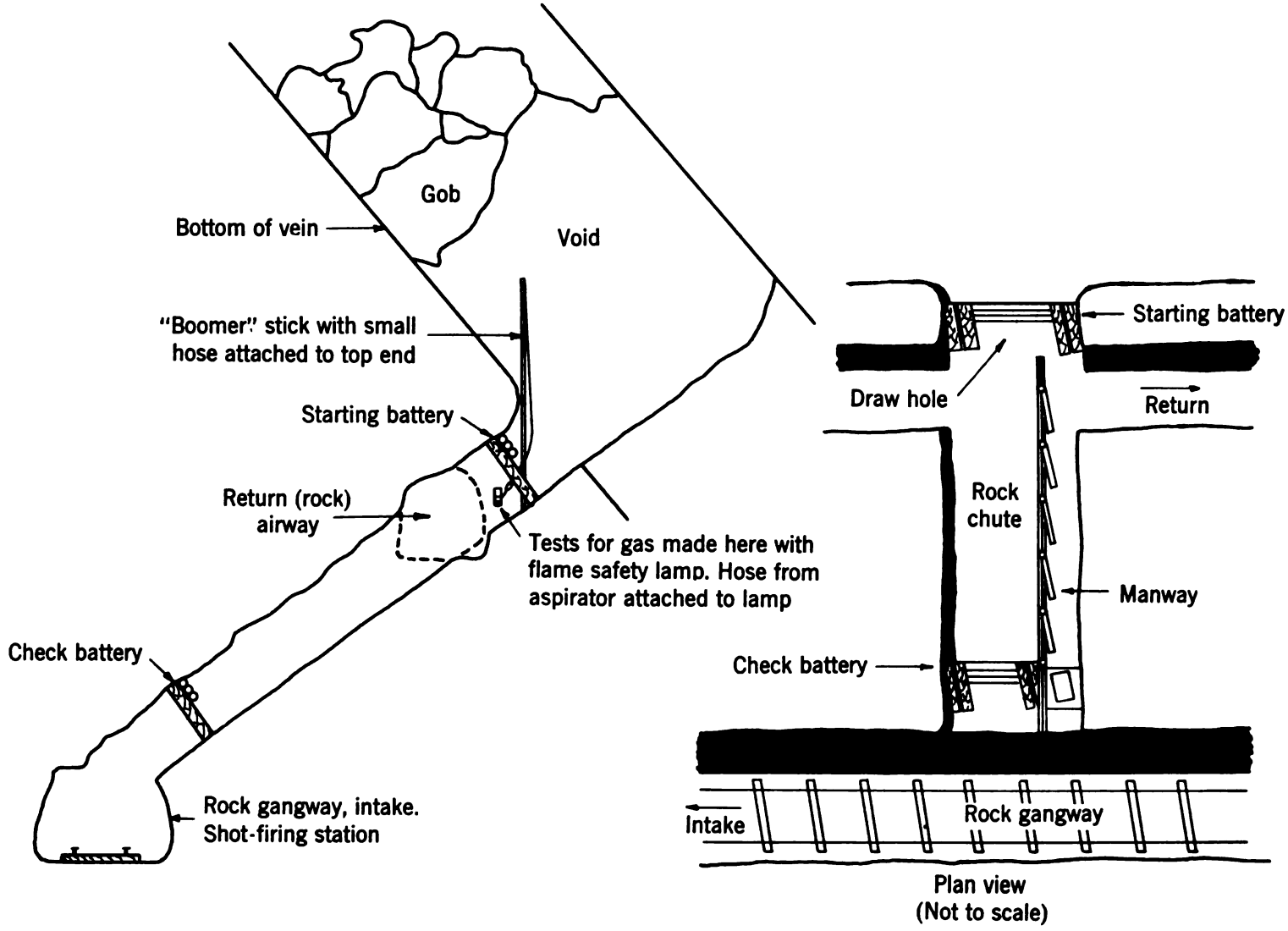

Figure 4. - Method of testing for gas in out-of-reach places.

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CONCLUSIONS

The simplicity of this device for testing for methane in out-of-reach places makes it easily available; it is efficient in the hands of any person who is acquainted with normal operation of a permissible flame safety lamp. Gas-testing methods described here are safe and reliable and can be employed to considerable advantage over previously adopted methods. One of the most important features is that explosive gas can be detected readily without thrusting the flame safety lamp into such gas, thereby eliminating a hazard presented by the defective lamp. There now appears to be no plausible excuse for inadequate or perfunctory gas tests in out-of-reach places. Adoption of the methods suggested should at least minimize the recurrence of gas explosions, consequently save lives and prevent injuries.

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